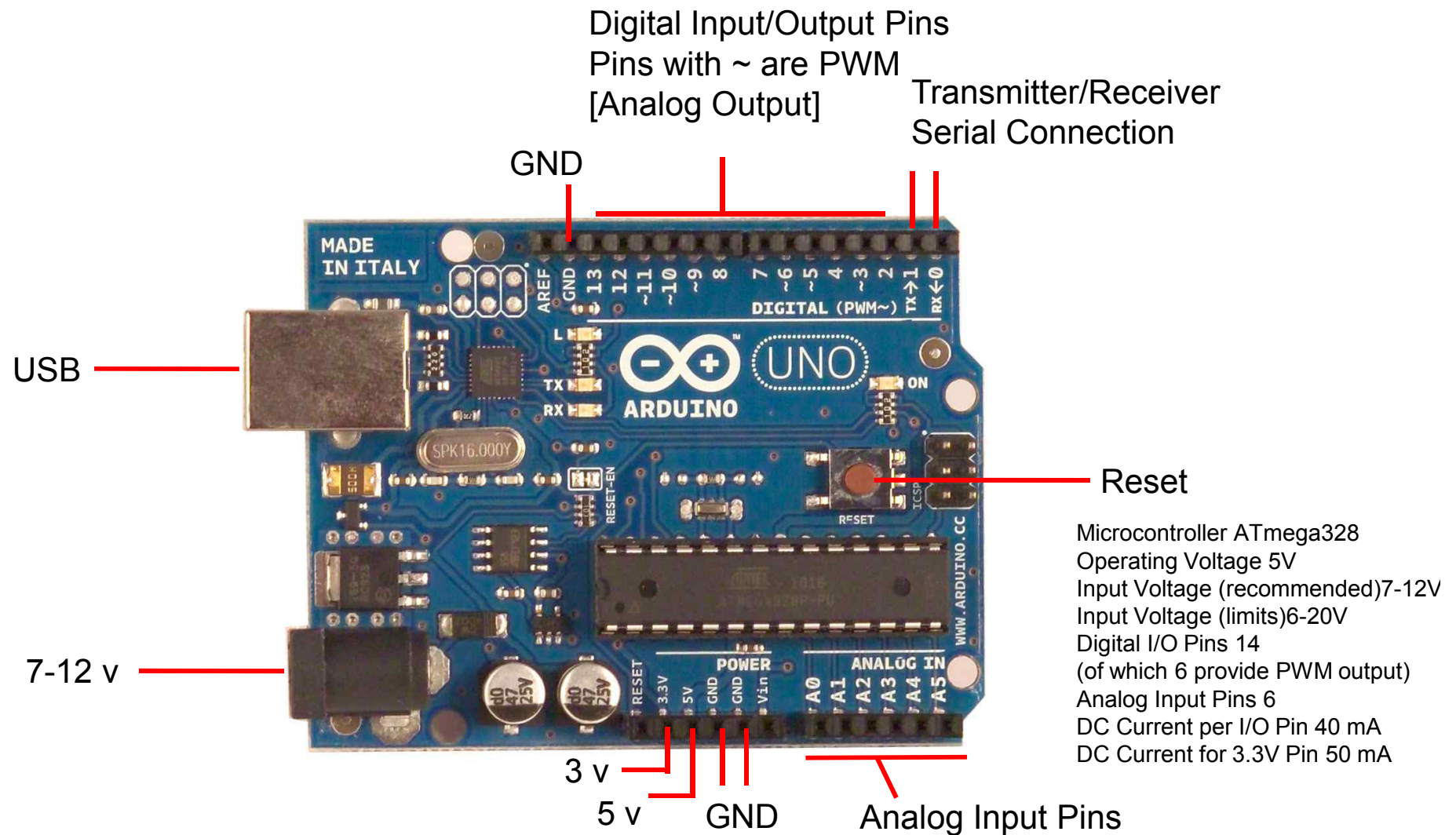

Robot Programming #3

디지털 출력

Dept. of Mech. Robotics and Energy Eng.
Dongguk University

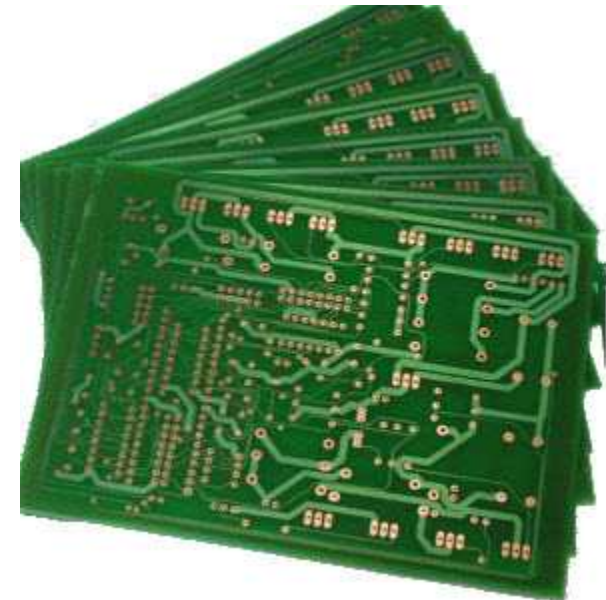
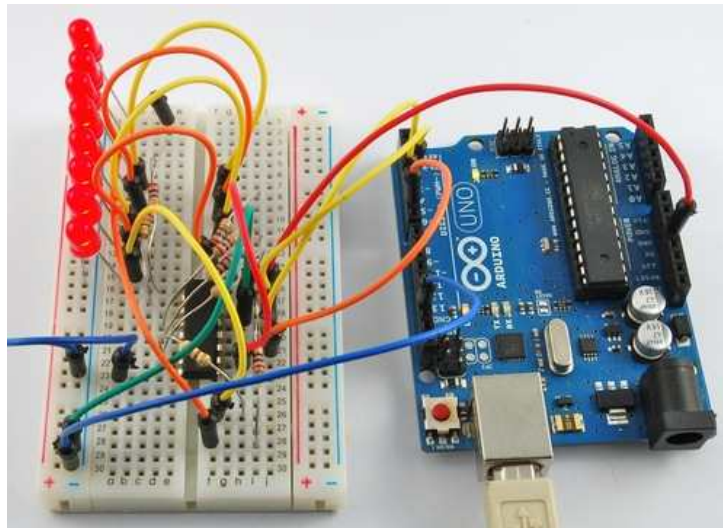


Arduino Uno



Arduino Pin Connections

- Various input and output devices are connected through pins.
- Breadboards are used to test an electric circuit before making a PCB.



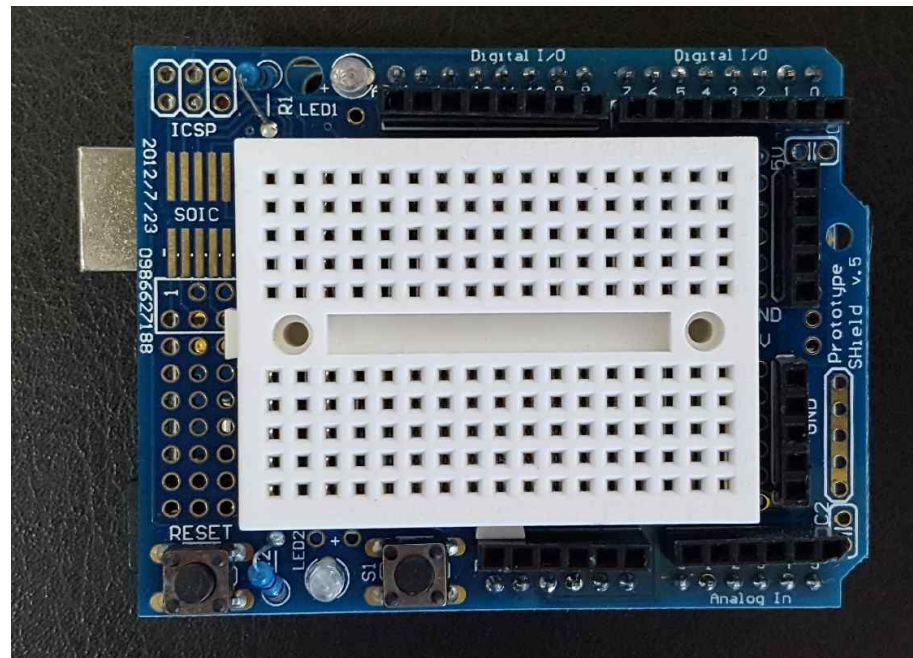
Arduino with Shield

- There are numerous Shields for the Arduino.
- We can plug a specific shield into the Arduino Uno board like below to easily perform tasks.



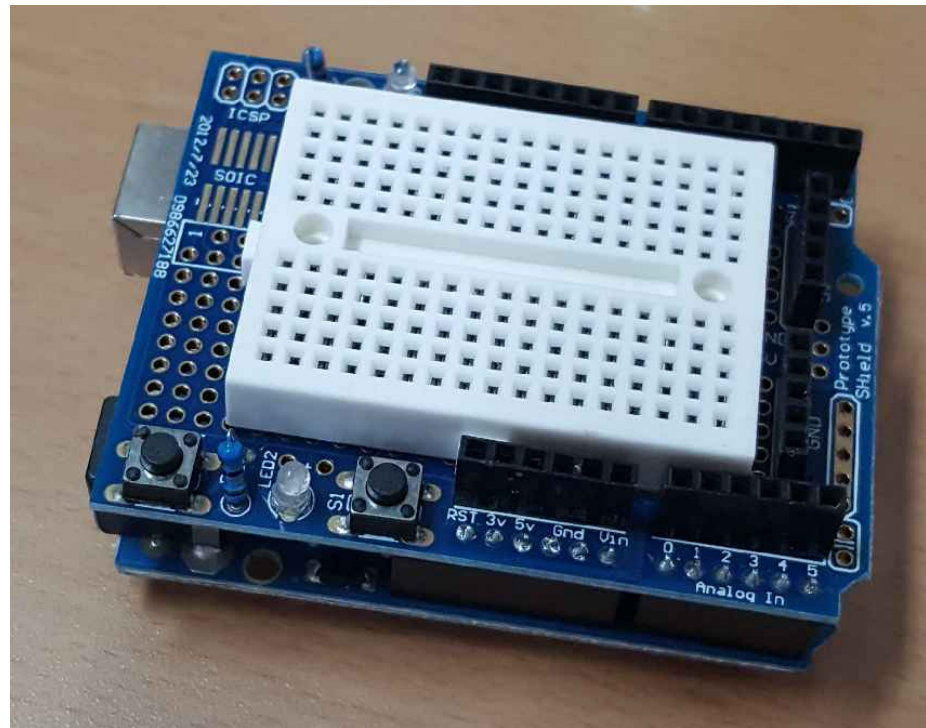
Breadboard Shield

- The breadboard shield can be plugged into the Arduino Uno board.
- Ports are placed on the same position as the Arduino Uno.



Breadboard Shield

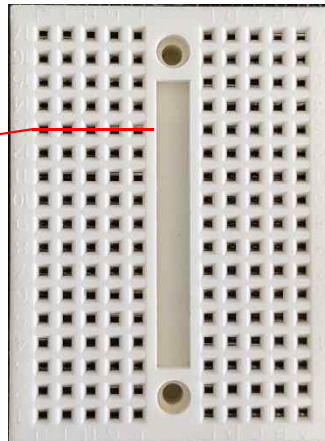
- Let's plug the breadboard shield into the Arduino Uno board as shown below.



Breadboard

- A **breadboard (protoboard)** is a construction base for prototyping of electronics. The term is commonly used to refer to **solderless breadboard (plugboard)**.

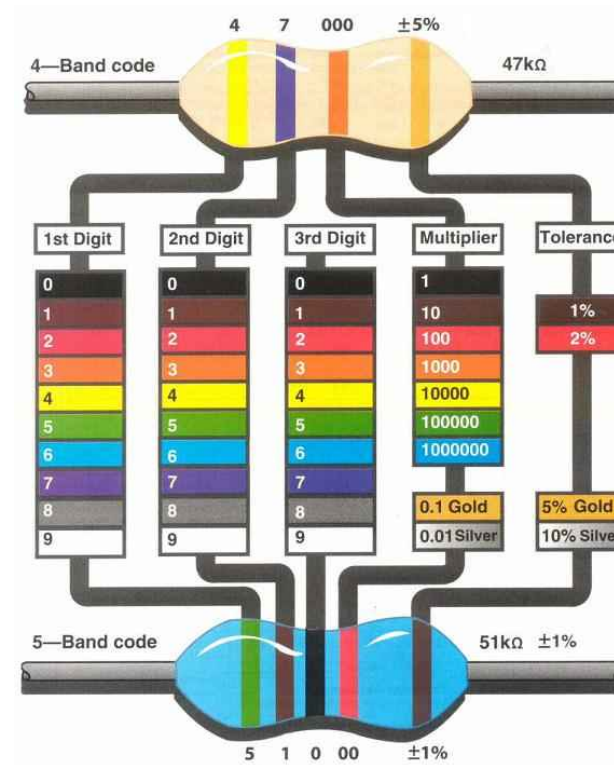
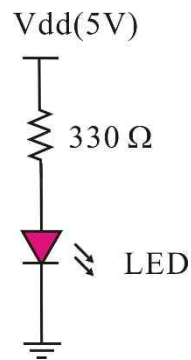
Holes of each row
are connected.



- In some other breadboards, vertical holes of each column are connected.

Our First LED Circuit

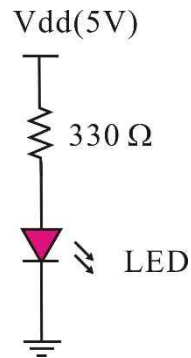
- Let's test the LED using the bread board.



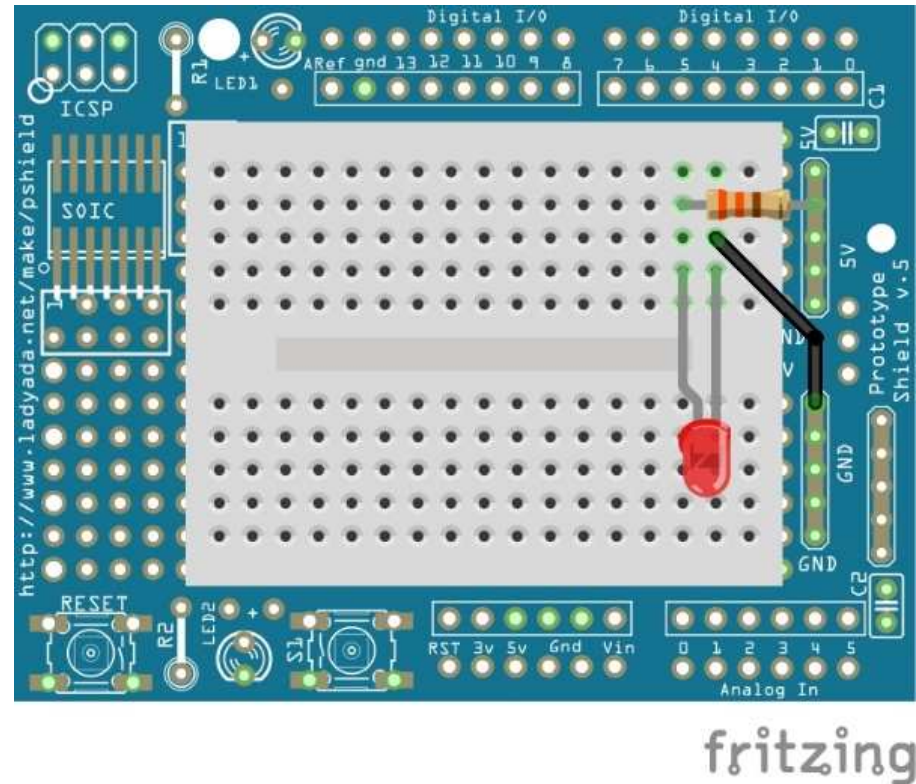
- Resistor Value: $R = ab \times 10^c \pm \text{tolerance}(\%)$

Our First LED Circuit

- Let's test the LED using the bread board.

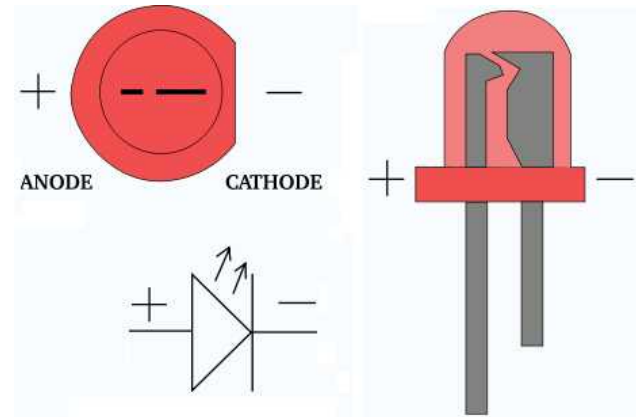


The long leg is +.



LED(Light Emitting Diode)

- LED is a diode, which means current can flow only in one direction.
- LED can be regarded as a valve in mechanical systems.
- To make it light, connection should be correct.



Introduction to digital terminology

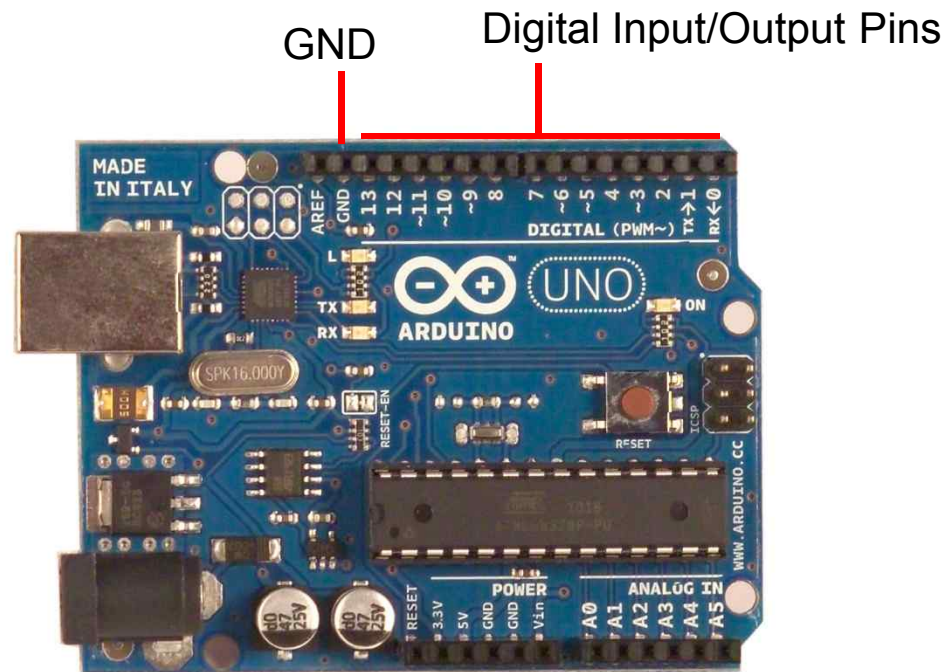
- The Arduino uses a power rail of 5.0 Volts – 0 Volts indicates 'off' and 5.0 Volts indicates 'on'.
- A number of terms are used interchangeably to describe on and off in digital systems:

0V	5.0V
Open	Closed
Off	On
Low	High
Clear	Set
logic 0	logic 1
False	True

- Note: terms 'logic 0' and 'logic 1' may be simply referred to as '0' and '1'.

Digital I/O of Arduino

- On the Arduino, the fourteen are digital inputs/outputs (0~13) which have been specially configured to operate with no extra wires or connections needed.



Digital Output

- Each pin can be configured to do input or output.

- Usage: `pinMode(pinNumber, pinState)`

- Examples:

```
pinMode(13, INPUT)
pinMode(11, OUTPUT)
```

- Only HIGH and LOW values can be assigned.
- Usage: `digitalWrite(pinNumber, HIGH/LOW)`

Digital outputs on the Arduino

- The digital IO pins are configured by defining them at the start of the program code.
- Each digital IO has a pin number and direction, for example:

```
pinMode(11, OUTPUT);
```

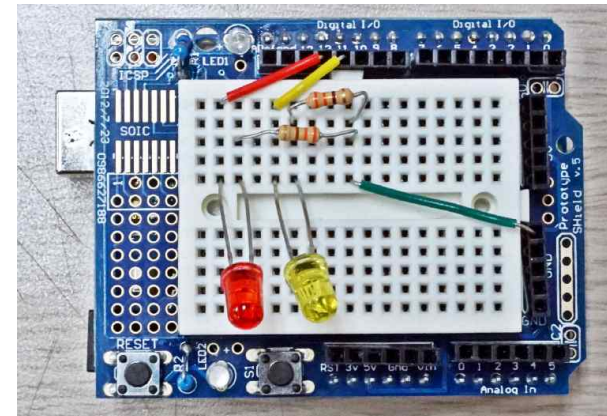
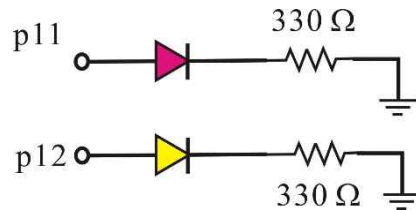
- The digitalWrite interface can be used to set the state of the output pin

```
digitalWrite(11, 1);
```

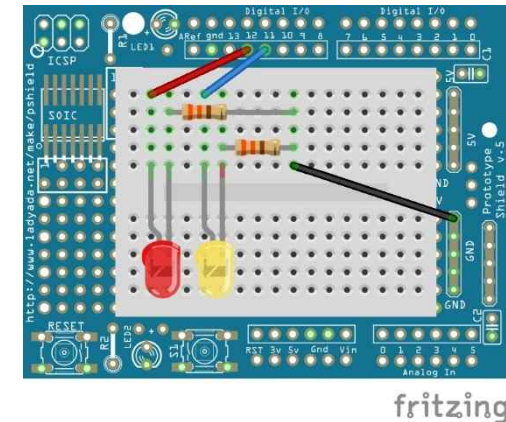
- Set the value to 0(LOW) to turn it off, or 1(HIGH) to turn it on.

Connecting LEDs to Arduino

- Connect a red LED to pin 11 and a yellow LED to pin 12.



- Remember to attach the positive side of the led (the side with the longer leg) to the pins. The negative side should be connected to ground. Use wires.



Connecting LEDs to Arduino

- Create a new program for the external LEDs.

```
int rLED = 11;
int yLED = 12;
void setup() {
    pinMode(rLED, OUTPUT);
    pinMode(yLED, OUTPUT);
}

void loop() {
    digitalWrite(rLED, 0);
    digitalWrite(yLED, 1);
    delay(500);
    digitalWrite(rLED, 1);
    digitalWrite(yLED, 0);
    delay(500);
}
```

- Compile, upload and run the code.

Connecting LEDs to Arduino

- Let's look at the program.
- Two pin numbers are assigned to integer variables.

```
int rLED = 11;  
int yLED = 12;
```

- Pins are configured to be output.

```
void setup() {  
  pinMode(rLED, OUTPUT);  
  pinMode(yLED, OUTPUT);  
}
```

- The setup function runs once when the program starts.

Connecting LEDs to Arduino

- The loop function runs repeatedly.
- This is where you put your algorithm!

```
void loop() {  
  digitalWrite(rLED,0);  
  digitalWrite(yLED,1);  
  delay(500);  
  digitalWrite(rLED,1);  
  digitalWrite(yLED,0);  
  delay(500);  
}
```

- As you may already see, red LED and yellow LED turns on alternately.
- delay() is used for timing control.